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guest editorial

PSEUDOSCIENCE AND HYDROGEOLOGY

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Within the field of hydrogeology, or ground-water geology, we have regarded dowsing with amused tolerance and with seemingly little concern for the fact that, as water finders, we are in the distinct minority. Reliable data are lacking, but my own experience suggests that more than three times as many drilling sites are located by dowsing than are located by conventional science. At least two things should be apparent. First, we may have convinced ourselves that we are using effective methods but, judged on the basis of general public acceptance, we are still in the Dark Ages. Second, we need to advertise and perhaps greatly improve our usefulness to the public, particularly in the art of ground-water exploration. A dowser will locate the exact spot for drilling. The geologist will only locate general areas where wells might be successful. Moreover, a truly gifted dowser can make his twig respond to questioning. In this way he is able to provide chemical analyses, detailed logs, and production figures for grateful clients prior to the investment of large amounts of money for drilling. In addition, distance is no barrier to the dowser who uses maps. Even water on Mars, if present, can be located in the comfort of an earthbound office. How can we compete with such talent!

It is not enough, however, to belittle the methods of pseudoscience. We must prove our distinct superiority over bent wires, pendulums, fancy boxes with dials and lights, or just the unadorned forked twig. The effort needed is generally distasteful to researchers who have little enough time for the serious study of science without becoming involved with what some may consider to be quaint folkways of the uneducated. Until we become interested, nevertheless, we will be defenseless against those who claim either that geology is ineffective or that dowsing is highly useful. Only two relevant studies of significant scope come to mind. One was in South Australia, the other in South Africa. Data gathered on more than 3000 wells by L. K. Ward in South Australia suggest that dowsing is no more useful than unguided random location of water wells. On the other hand, studies in South Africa by J. F. Enslin indicate that geophysics coupled with geology can improve the effectiveness of water-well location in very difficult terrane by as much as 60 percent. These isolated studies are encouraging, but many similar studies are needed to help instill confidence of the general public in the work of the hydrogeologist.

If dowsing were the only manifestation of pseudoscience in hydrogeology, the problems encountered would be relatively simple. Pseudoscience in hydrogeology, nevertheless, ranges from strange concepts of water circulation to impossible theories of hydrochemistry. Many people in Australia believe that their artesian water comes from snow melt in the Himalaya Mountains. A

driller not too far from San Francisco, California, advises that water wells be drilled below sea level so that sea water can flow into the wells. The water is thought to be freshened by filtration. Other people would not be disturbed with the saline water if it reached the well, because sea water is reported by some pseudoscientists to give the human body a chemical smorgasbord which is necessary for proper health. For those concerned with excessive dissolved solids, devices can be clamped to the outside of distribution pipes. The devices are reported to adjust the ion content of the water by a magical force field. These curious artifacts, however, have all but disappeared from the water industry through efforts of the government.

Few pseudoscientific theories concerning ground water have gained a widespread following among educated people. An interesting exception is the general theory of "primary" water which claims that large quantities of water from sources deep within the earth are available for human utilization. Several wells have been drilled which produce water that is claimed to be unrelated to either present or past hydrologic cycles. Some versions of this theory state that the water is derived from the chemical union of hydrogen and oxygen given off from magmatic sources. In many ways the general theory is similar to a popular theory of the 17th Century which visualized ground water coming from the products of metabolism within a living earth. Lack of field data in support of the theory together with insuperable problems of transmissivity, water temperature, and water chemistry make the modern counterparts no better than their ancient forerunners. Arguments against the theory of primary or interior water are a bit technical, so it is easier for some to follow the crusading spirit of the advocates. Enthusiasts of the theory at one time included several prominent industrialists, at least two university instructors, one university official, several clerics, an engineer, and one geologist holding a Ph. D. degree. Although the movement appears to have lost some strength during the past two or three years, it is by no means dead.

People often search for a foolproof method to distinguish the true scientist from the pseudoscientist. There is, of course, no easy method, particularly in fields such as parapsychology where the investigators occupy the entire spectrum of credibility – from mediums to serious researchers. The pseudoscientist rarely has an outward appearance that would set him apart in a social gathering. He does not usually converse in an irrational manner nor does he appear sinister or addled. Surprising as it may seem, the criterion of correctness does not always prove to be a reliable guide. The pseudoscientist, unencumbered by facts or formal methods, can fish for explanations with hundreds of wild guesses and arrive quite by chance at a correct hypothesis. The plodding scientist, in contrast, may occasionally work years to test a single theory that is eventually proved to be incorrect. The only consistent difference between scientists and their imitators is in methodology. There is no substitute for the proper sequence of scientific effort, namely: (1) accurate observation and measurement of physical objects or events, (2) formulation of multiple hypotheses to explain observations, (3) careful testing of all the hypotheses, and lastly, (4) formulation and presentation of the final conclusions.

For the past six years I have had the opportunity in a special senior colloquium to review with my students the biographies of a large number of pseudoscientists and to puzzle over the question of why a person should choose to be a pseudoscientist. I am sure that my insight into the problem is still rather shallow, but several factors appear to be prominent. The most common factor is that the individual is convinced through intuition, religion, or scientific dogma that some particular hypothesis fits the facts of nature. Subsequent work is directed only to searching for data to fortify preconceived notions. A closely related failure is the tendency of some people to become so emotionally attached to their own work that omissions and errors are defended and enlarged upon rather than corrected. Another common shortcoming is an impatience with the tedious nature of much of true science. The scientific method is consequently short-circuited with quaint and sometimes astounding

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results. Part of the impatience may be caused by a strong desire for the prestige of science without the desire, or perhaps the ability, for the necessary education and training. The glamour of higher mathematics, computers, and outer space jargon has special appeal to these people.

To all except the most smug it should be apparent that all of us are susceptible to practicing at least some pseudoscience. Therefore, our first concern in hydrogeology is to exercise vigilance over our individual thought habits. At the same time we should give more attention to helping educate the public so it will not be duped by those who are clearly the false prophets of science. In this way we will have a much more useful, albeit less colorful, profession.

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'The objectives of this association shall be: to assist, promote, encourage, and support the interests and welfare of the water well industry in all of its phases; to foster, aid and promote scientific education, standards, research, and techniques in order to improve methods of well construction and development, and to advance the science of groundwater hydrology; to promote harmony and cooperation between well contractors and scientific agencies relative to the proper development and protection of underground water supplies; to encourage cooperation of all interested groups relative to the improvement of drilling and pumping equipment; to encourage, serve, assist and promote closer cooperation among the existing state water well contractors associations and to foster the development of such associations in states where they do not exist; to collect, analyze, and disseminate to the public facts about the role of the water well industry in the economy of the nation; and to advance generally the mutual interests of all those engaged in the water well industry, in their own and the public welfare.

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Membership is open to:
"those who are engaged in occupations pertaining to the supervision, regulation, or investigation of ground water or ground-water supply installations or who are teachers or students at recognized institutions in academic fields related to the study of ground water."

The purposes of this Division are:
"to cooperate with other Divisions of the N.W.W.A. in fostering ground-water research, education, standards, and techniques; to advance knowledge in engineering and science, as related to ground water; and to promote harmony between the water well industry and scientific agencies relative to the proper development and protection of ground-water supplies."

Individual membership dues in the Technical Division ($10.00 per year) include a subscription to Ground Water in addition to the Water Well Journal. Membership application forms available upon request.

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